ABSTRACTS OF PAPERS

A STUDY OF PROPAGATION OVER THE ULTRA-SHORT-WAVE RADIO LINK BETWEEN GUERNSEY AND ENGLAND ON WAVELENGTHS OF 5 AND 8 METRES (60 AND 37·5 Mc./s.)

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(Abstract *of a Wireless Section paper (official communication from the National Physical Laboratory) which will be published, in March, in Part III of the Journal.)*

The paper presents a survey and analysis of field-intensity measurements obtained during the years 1937–1939, over the Post Office radio-telephone link between Guernsey and Chaldon, England, on wavelengths of 5 and 8 m. (frequencies 60 and 37·5 Mc./s.). The path between the stations was almost entirely over sea and about 85 miles in length, of which some 36 miles was outside the optical range.

The data consisted of continuous records, 24 hours a day, of received current. Typical records are shown in Fig. 1. The four types of intensity variation shown in this figure are indicative of those obtaining in general throughout the period of observations.

In type (*d*) the mean intensity of signal tended to be rather high, while in the flat type (*a*) it was usually somewhat low. The rapid fading was usually superposed upon flat records and was present mainly in the 5 m. reception in the winter months. In general there was no definite regular

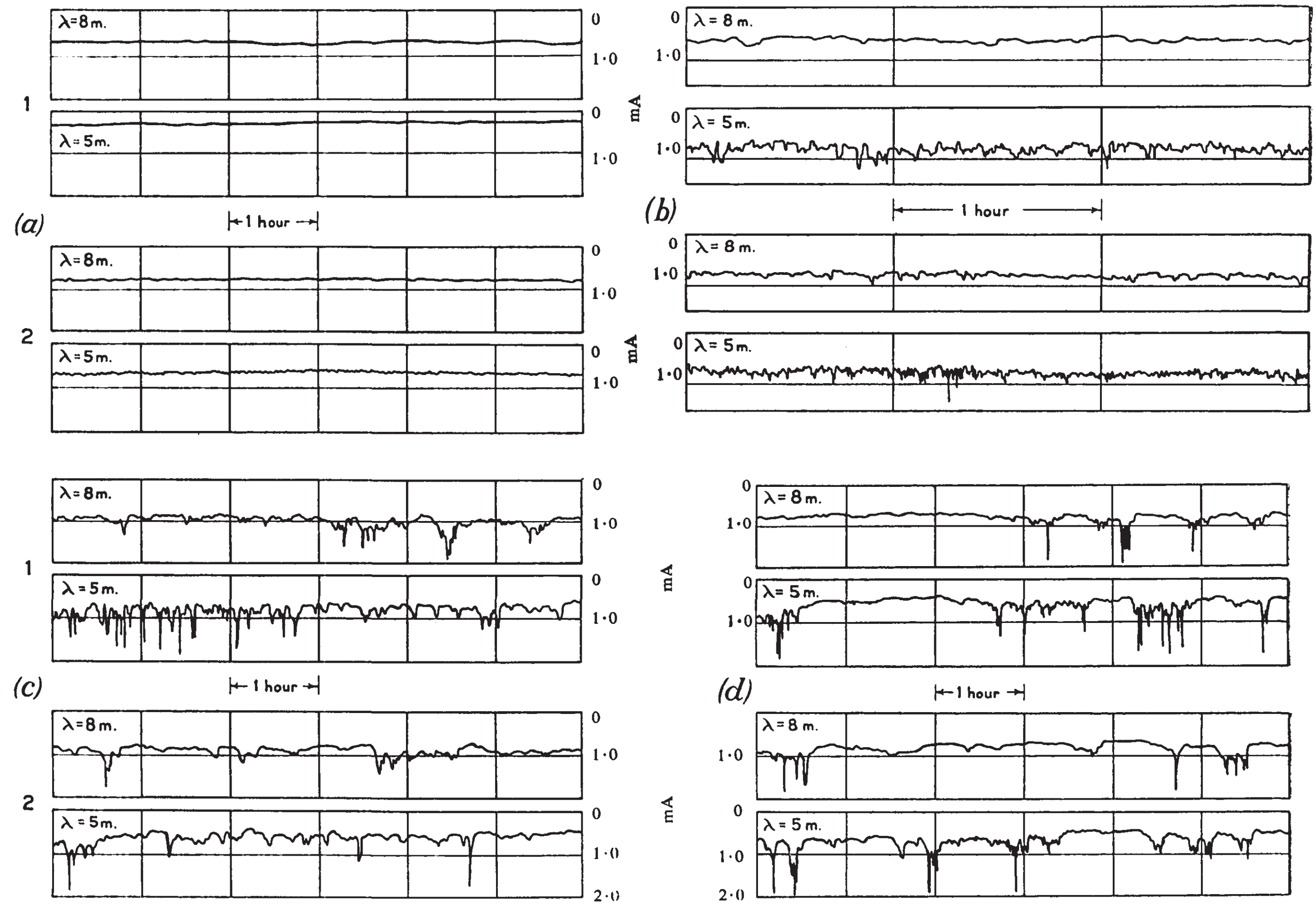

Fig. 1.—Samples of various types of fading.

(*a*) 1. Flat in presence of fog.
2. Flat.
(*b*) Rapid (mainly on 5 m.).
(*c*) 1. Medium.
2. Medium with trace of slow.
(*d*) Slow.

variation either of mean intensity level or of fading about this level, but similarity of type of fading was noted as a usual occurrence on the two wavelengths, although in no instance was there simultaneity in individual fades.

A quantitative study of the records confirmed the similarity of type on the two wavelengths, and the lack of both diurnal and true annual variation; on the other hand, the results suggested a long-term secular variation in which fading on 5 m. tended to increase to a maximum over the period of observations, while that on 8 m. decreased. The period of two years over which the observations were taken was insufficient, however, to allow of any conclusions being formed as to an explanation of this trend.

Comparison with meteorological data showed a marked correlation between periods of very little fading and the presence of low-pressure systems, while periods of fading predominantly of the "slow" type occurred at times of anticyclonic conditions. This, together with the fact that fading, while always less in winter than in summer, showed no regular seasonal variation, led to the conclusion that the winter decrease was due to the greater prevalence of low-pressure systems during this season. These correlations are seen in Fig. 2, which shows that peaks of intensity and of fading of the "slow" type coincide with peaks of pressure, while troughs of pressure coincide largely with zero fading and flat records of average intensity.

A simple theoretical treatment of the propagation of waves through the lower atmosphere shows that account must be taken of the various paths by which rays can pass from transmitter to receiver, these rays being subject to diffraction, refraction or reflection on the way. The received signal is the resultant of the various rays received, and it is clear that interference effects may result from the arrival of two rays simultaneously by different paths. Sudden changes in the temperature and water-vapour content in the atmosphere produce corresponding changes in refractive index and so cause marked bending of the rays transmitted. In regions of temperature inversion these conditions may be specially marked, resulting in the ray being completely bent over and returned to earth in a manner analogous to reflection from a discontinuity.

An explanation of the lack of fading in bad weather and of the pronounced fading in good weather is sought in the fact that in anticyclonic conditions temperature inversions and associated sudden changes in relative humidity are usually present at heights of 1 to 2 miles, whereas in cyclonic or depression conditions these are absent. Now temperature inversions are present near the ground during anticyclonic weather over land, and show a marked diurnal effect due to the small thermal conductivity of land. Over the sea such inversions are not so marked, and this probably accounts for the complete lack of diurnal variation of signal intensity and fading in the present set of observations. This fact is upheld by the results of other workers, notably Englund, Crawford and Mumford in America, who found a diurnal variation in observations over land, and a lack of diurnal variation in observations over sea.

On the other hand, the general structure of the atmosphere in an anticyclone is probably the same over the sea as over land; in particular, changes in water-vapour content may

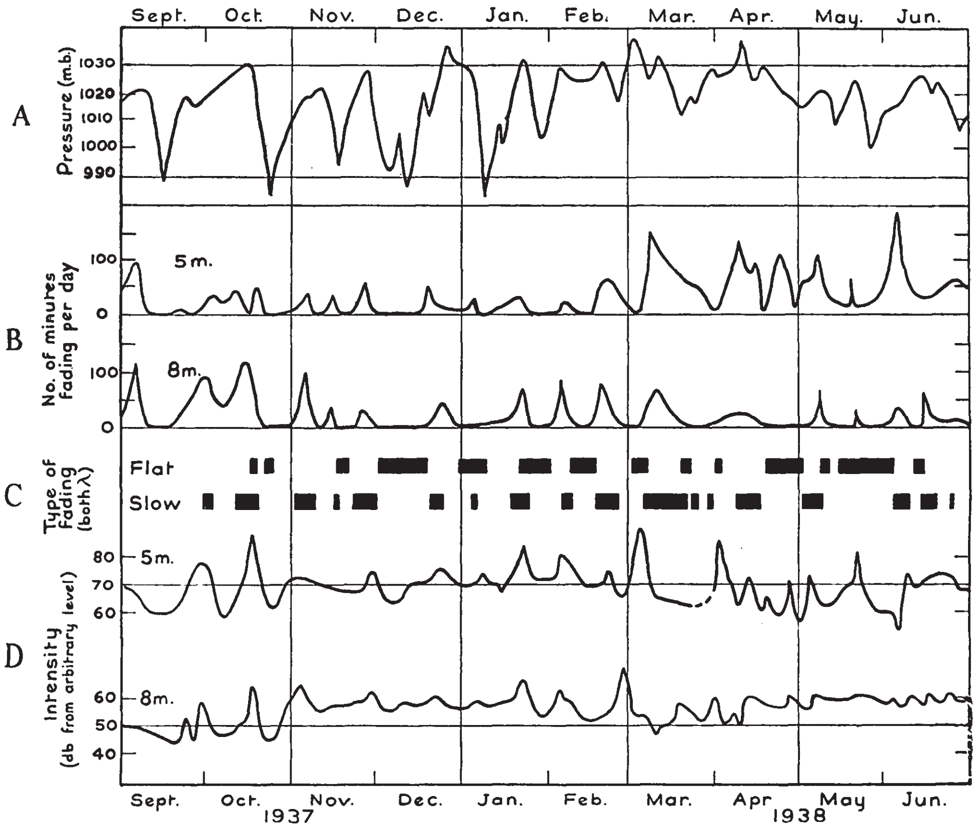

Fig. 2.—Correlation of intensity variation with barometric pressure.

still obtain over the sea, giving rise to refraction in the lowest layers and thus causing sufficient bending of the direct ray, to account for the received signal and its variations. As mentioned above, rapid fading occurred mainly on the wavelength of 5 m. and was usually superposed on flat records, being present only in winter. It is thought that this is probably a shimmering effect due to turbulence in the atmosphere during bad weather. A similar effect had previously been noted by Ross Hull in America and was attributed to the same cause.

A more detailed study of the radio phenomena on the above lines has not been possible on account of the limitations imposed by the nature of the meteorological information available at the place and for the period of the wireless observations. In future investigations this limitation may be at least partly removed, by improved meteorological technique for studying conditions in the lower atmosphere, and by making arrangements for special and close cooperation between those responsible for the wireless and meteorological observations.